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Fertilization Has Mixed Effect on Planted Nuttall Oak Seedlings

The reestablishment of bottomland hardwood forests on old agricultural fields and other disturbed sites is becoming an increasingly important Service activity, in large part because of legislative and policy initiatives such as the Food Security Act of 1985 (the "Farm Bill") and the North American Waterfowl Management Plan. This is especially true in the Lower Mississippi Valley, where more than 80% of the original forests have been lost.

To provide support for reforestation, we are evaluating several sites that the Service has reforested since 1968. Here we report on one case study – a reforestation site where, by accident, one half of the field was fertilized and one half was not.

Reforested Site's History Investigated

The stand we investigated is approximately 8 acres near the northern end of Hillside National Wildlife Refuge in west-central Mississippi. The soil type is a well-drained Morganfield silt loam.

We reconstructed the site's history through a combination of personal communications and investigation of written records. The field had been cleared of forest for at least 45 years and had been used as pasture or planted with cotton, soybeans, and wheat. In some years the field had been double cropped with soybeans and wheat. In 1970, a fence was constructed through the middle of the field, after which the management differed from year to year on each half.

The site was planted in March 1982 with bare-rooted 1-year-old Nuttall oak (*Quercus nuttallii*) seedlings at a spacing of 11 by 11 ft, or 360 seedlings per acre. The seedlings' roots were pruned to a length of about 8 inches just before planting, and the tops of most seedlings were also pruned. The seedlings were hand planted by a Young Adult Conservation Corps crew.

At the time of planting, the eastern half of the field was bare except for soybean stubble. Because of a misunderstanding, a contract farmer had sown a crop of winter wheat on the western side of the reforestation site; the crop was about 3–4 inches high when the trees were planted. The farmer had also fertilized the field in March with 80 units (65 lb/acre) of liquid nitrogen (anhydrous ammonia). After planting, no weed control or other management was carried out on either side of the field.

Growth and Survival Evaluated After 7 Years

In May 1989, we established five 0.05-acre plots in each half of the field (about a 6% sample). In each plot, we located every Nuttall oak and measured the diameter at breast height (DBH). We found a significantly greater ($P \leq 0.001$) mean DBH on the fertilized side of the field. The mean DBH was nearly twice as large on the fertilized side ($\bar{x} = 2.8$ inches; s.e. = 0.14; n = 61) as on the unfertilized side ($\bar{x} = 1.4$ inches; s.e. = 0.63; n = 86).

On the other hand, the mean number of trees in the fertilized plots was significantly less ($P \leq 0.01$) than in the unfertilized plots. The means were 17.2 trees/plot (s.e. = 0.96; n = 5) for the unfertilized plots and 12.2 trees/plot (s.e. = 1.16; n = 5) for the fertilized plots. This translates to a mean of 344 trees/acre (or 95% survival) on the unfertilized plots and 244 trees/acre (or 68% survival) on the fertilized plots.

Possible Implications for Reforestation Projects

Significant increases in growth of bottomland oaks in response to fertilizer (N and N + P) treatments have been reported previously (Francis 1985), although none of the reported experiments involved Nuttall oak and most were on older, naturally established stands. Francis noted that the best responses to fertilizer were found on old field sites (vs. natural forest sites) and on medium-textured soils (vs. heavy clay soils) – the same conditions found at our site. No mention was made by Francis of reduced survival of bottomland oaks due to fertilization, however, perhaps because the studies he reported took place under carefully controlled conditions.

The most likely cause of lower survival on the fertilized portion of this field was damage caused by rodents and deer, perhaps compounded by a higher level of competition with herbaceous vegetation. The forester originally responsible for the site noticed more signs of rabbit, rat, and deer activity on the fertilized side of the field in the years immediately following the planting, probably because the growth of herbaceous vegetation was more lush. He also noted that the bark on many seedlings had been gnawed just above ground level, resulting in at least partial girdling. Some of the seedlings had also been damaged by deer rubbing their antlers against them.

Although we realize this is a case study, not a designed and controlled experiment, the results imply that fertilization can be useful in some cases. Nuttall oak seedlings exhibited a significant early-growth response to fertilization on this site, and other oaks have also been observed to respond to fertilization on old-field sites with medium-textured soils. Survival may be reduced as an indirect result of fertilization, but if it is reduced no more than it was in this case (i.e., to about 250 trees/acre at age 7), the losses may be regarded as an acceptable trade-off for the increased early growth of the surviving trees and the increased amount of use of the site by some wildlife species.

Although it is too early to assess the impacts of fertilization on mast production, it is likely that the larger trees on the fertilized side of this field will produce acorns earlier. Also, the trees on the fertilized side may produce more acorns per acre than the unfertilized side because of their larger size and more developed crowns. This can be expected to benefit both resident wildlife and wintering waterfowl.

Literature Cited

Francis, J. K. 1985. Bottomland hardwood fertilization – the Stoneville experience. Pages 346–350 *in* Proceedings of the Third Biennial Silvicultural Research Conference, Atlanta, GA. U.S. Forest Service, Southern Forest Experiment Station, General Technical Report SO-54. New Orleans, LA.

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